



Leveraging Geothermal

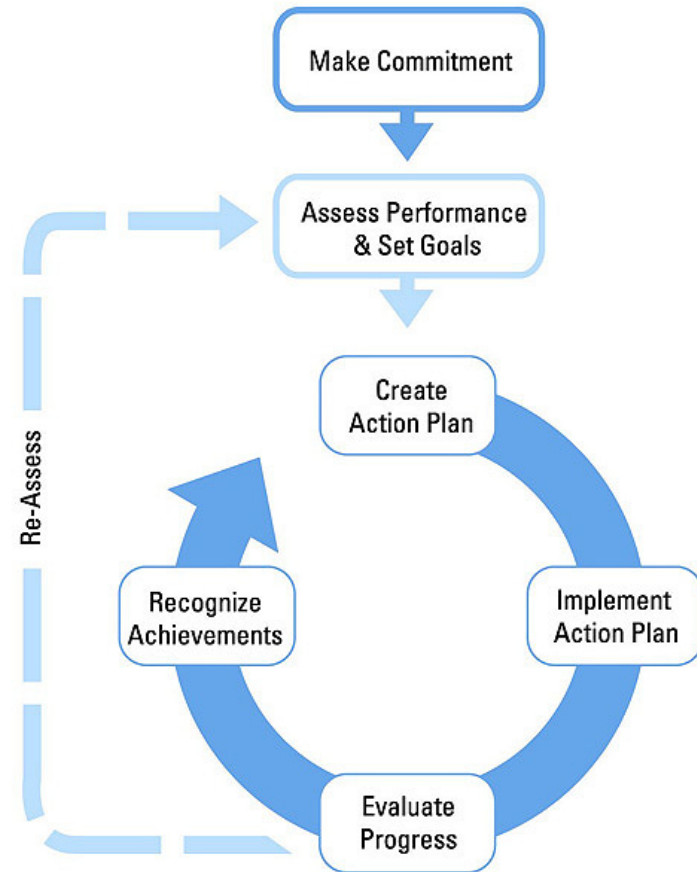
Monthly Partner Web Conference
February 17, 2010

Call-in number: 888 299 3188
Conference Code 202 343 9965#

About The Web Conferences



- Monthly
- Topics are structured on a strategic approach to energy management
- Help you continually improve energy performance
- Opportunity to share ideas with others
- Slides are a starting point for discussion



Web Conference Logistics



- Phones will be Muted
To ask a question use # 6 to un-mute
and * 6 – to mute
- Questions – use the chat window or ask question during the Q & A period.
- Presentation slides will be sent by email to all participants following the web conference.

Today's Web Conference

Speakers:

- John Kelly – Geothermal Heat Pump Consortium
- Mark Tschirhart – York County School Division
- Questions & Discussion
- Announcements



GEOHERMAL HEAT PUMP Fundamentals & Applications

ENERGY STAR PARTNER MEETING

MARCH 17, 2010

JOHN KELLY

GEOHERMAL HEAT PUMP CONSORTIUM



GEOEXCHANGE.ORG

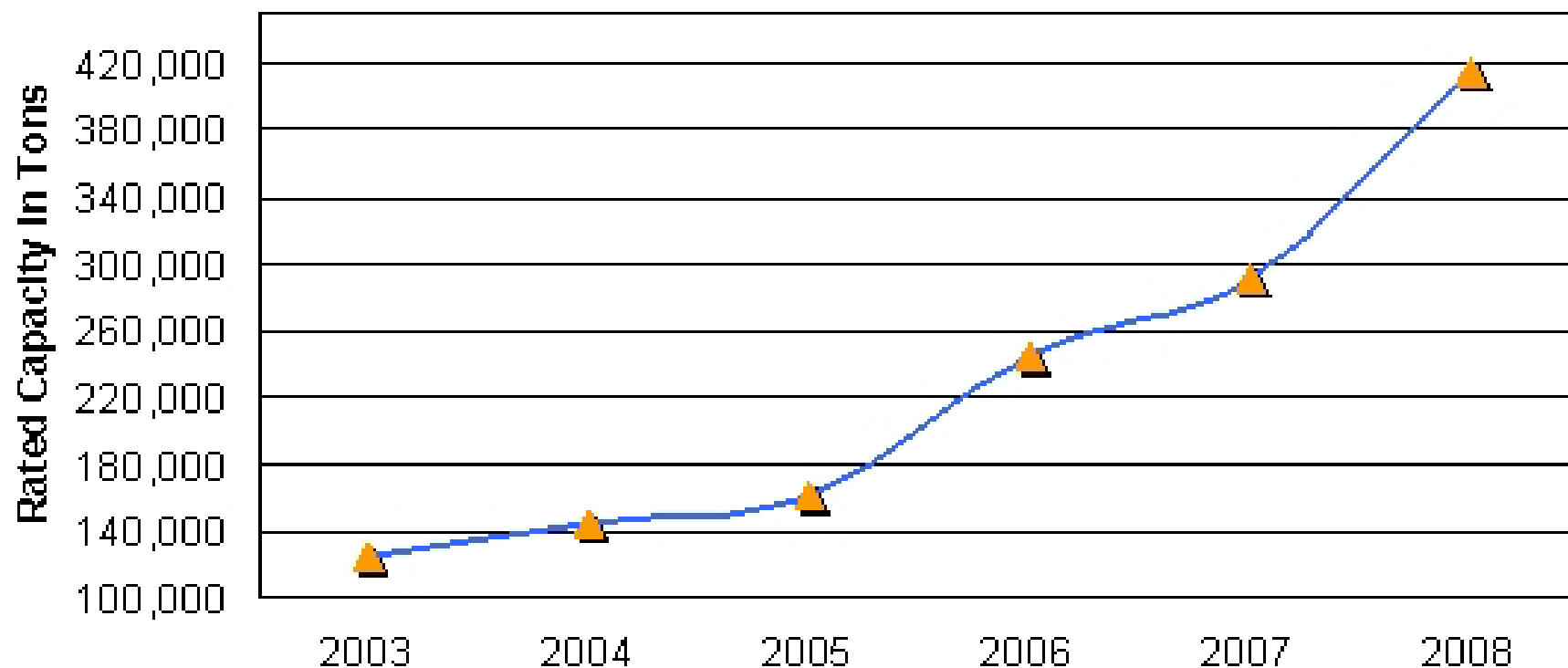
- NON-PROFIT TRADE ASSOCIATION
- SUPPORT MEMBER BUSINESSES
- EDUCATE DECISION MAKERS
- ASSIST CONSUMERS
- PROTECT GROUND WATER



GEOHERMAL HEAT PUMPS OVERVIEW

- MARKET
- INDUSTRY
- CONCEPTS
- OTHER CONSIDERATIONS
- RESOURCES

GHP MARKET





GHP MARKET

- RESIDENTIAL
- COMMERCIAL / INDUSTRIAL
- INSTITUTIONAL
 - SCHOOLS
 - HEALTHCARE
 - CORRECTIONAL
- GOVERNMENT: DOE, DOD, GSA, USDA, etc.



GHP INDUSTRY

- MANUFACTURERS
 - HEAT PUMPS
 - HDPE PIPE, PUMPS, GROUTS, DRILL RIGS...
- HVAC COMPANIES
- DRILLERS / GROUND LOOP INSTALLERS
- ENGINEERS / ARCHITECTS
- UTILITIES

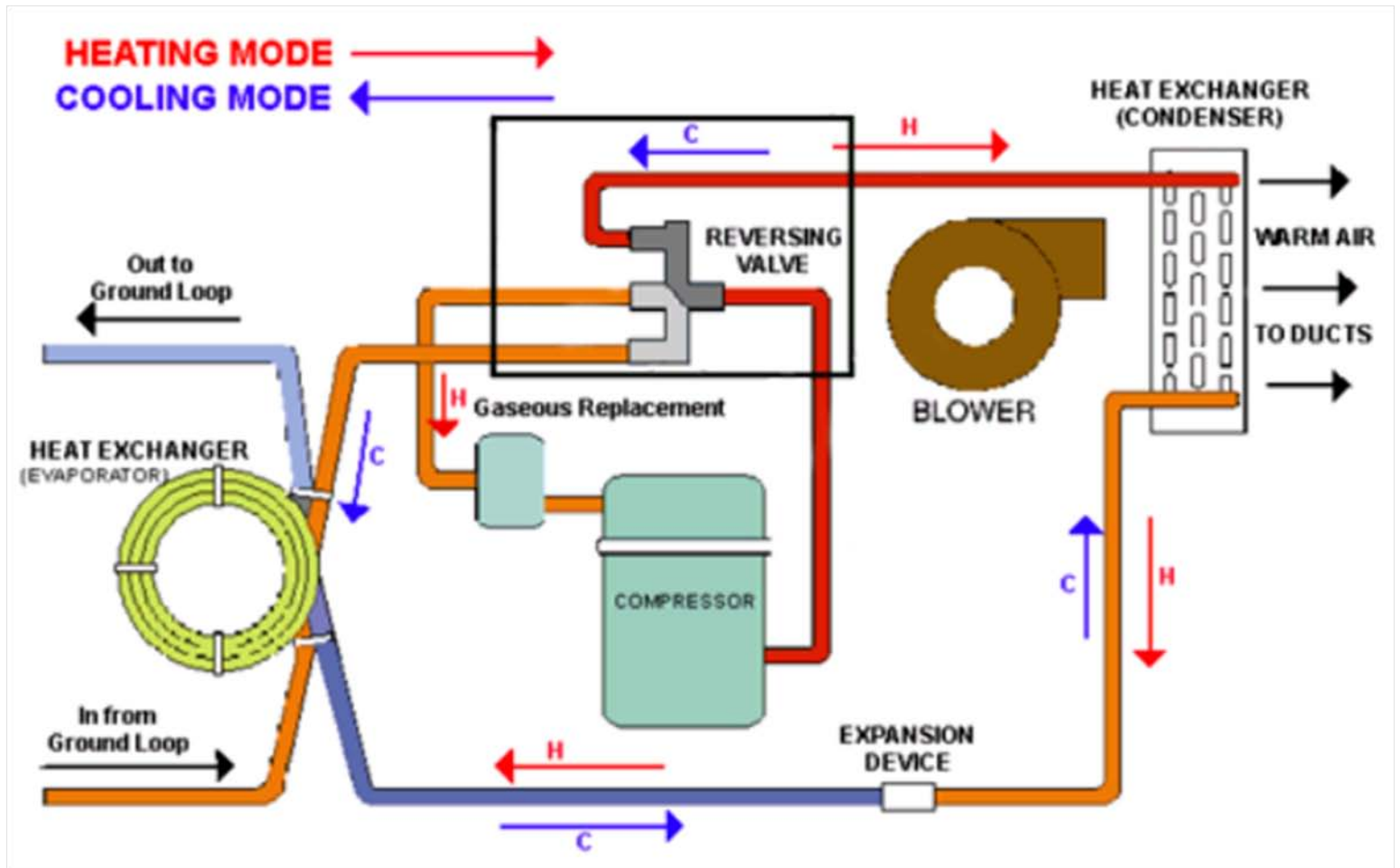


GHP CONCEPTS

- **HEAT PUMP**
- **CONVENTIONAL HEAT PUMP**
 - AIR SOURCE (conventional A/C or refrigerator)
 - WATER SOURCE (boiler/cooling tower)
- **GROUND SOURCE HP(earth or water)**
- **GEO THERMAL HEAT PUMP**
 - WATER SOURCE (not boiler/cooling tower)



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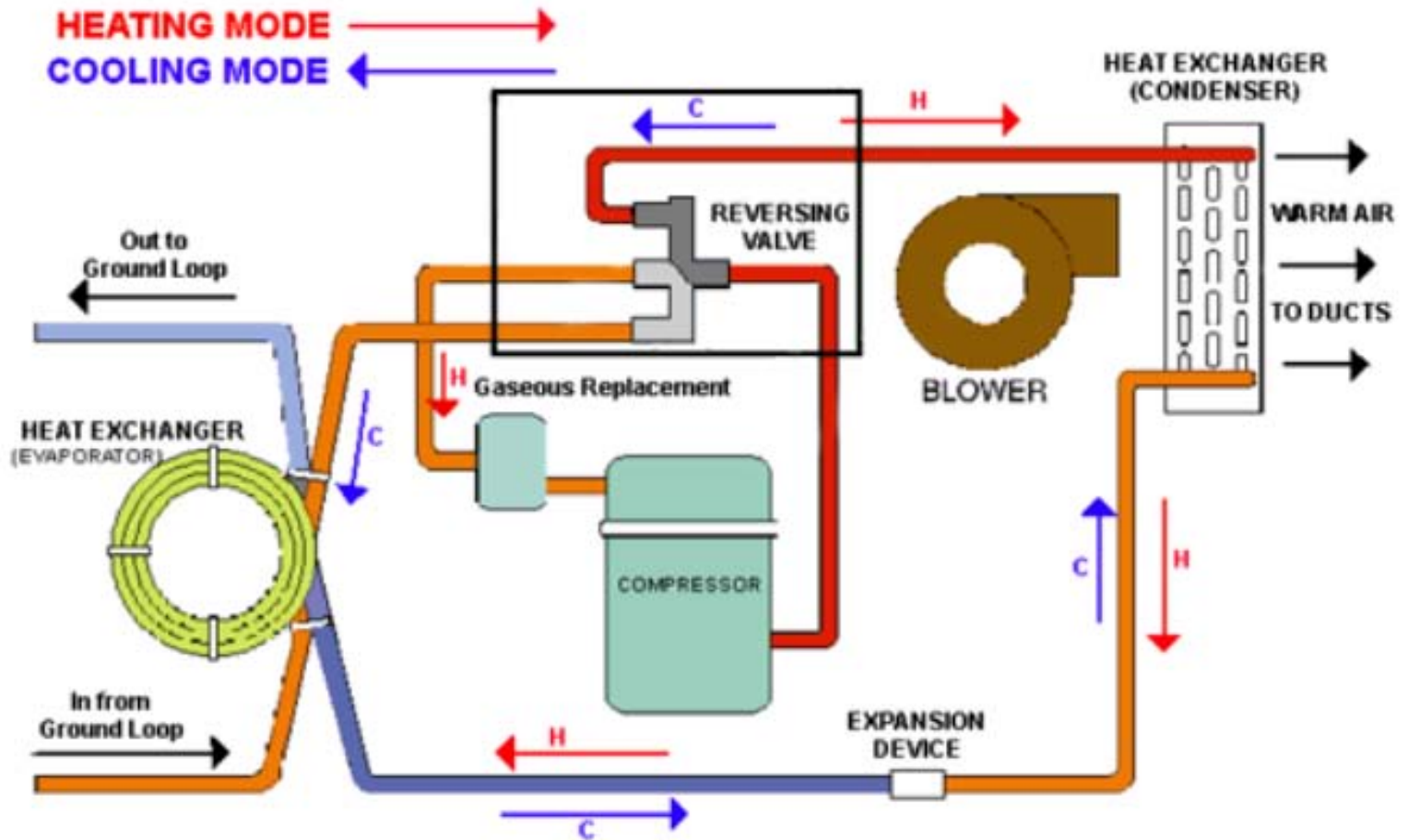


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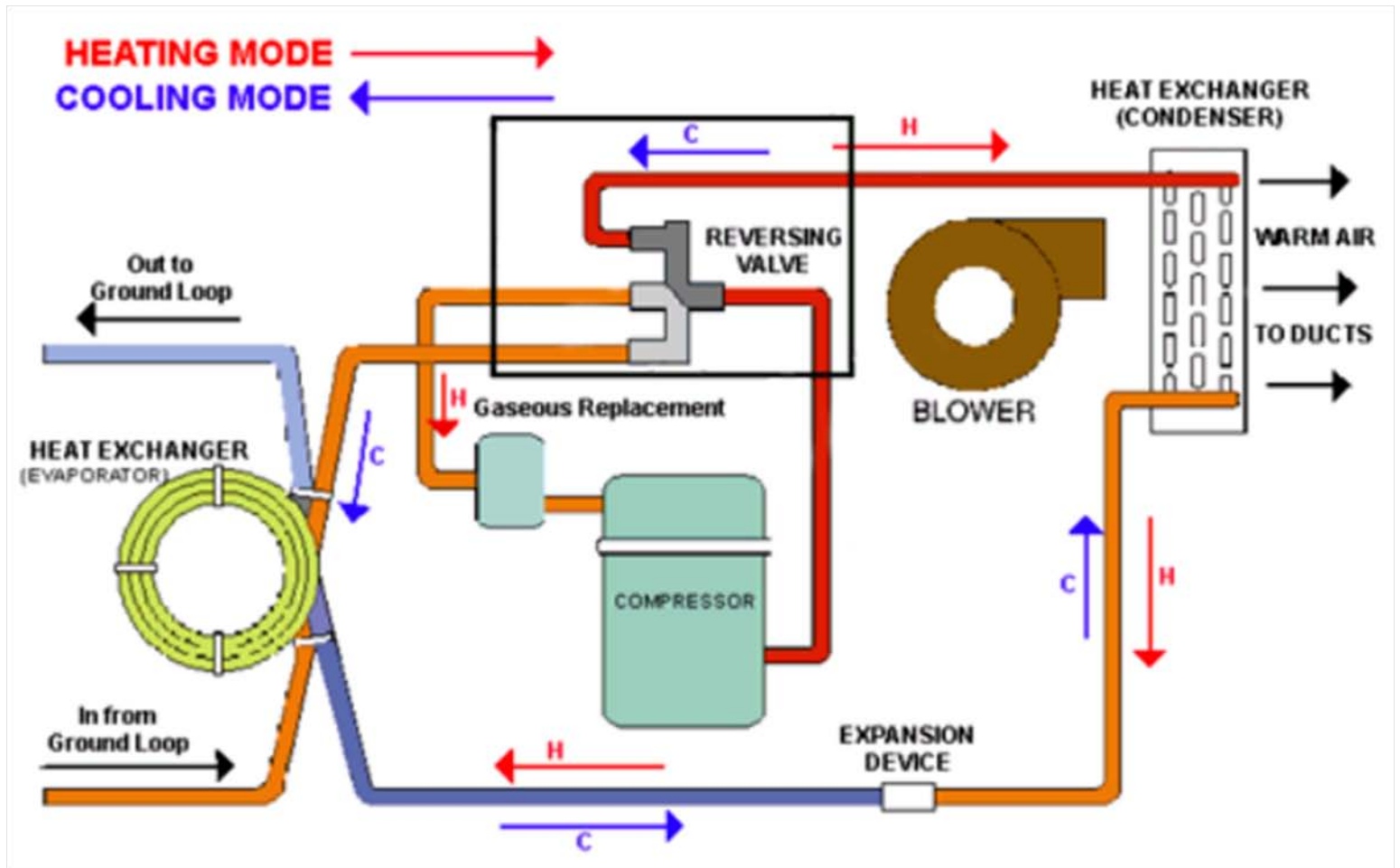


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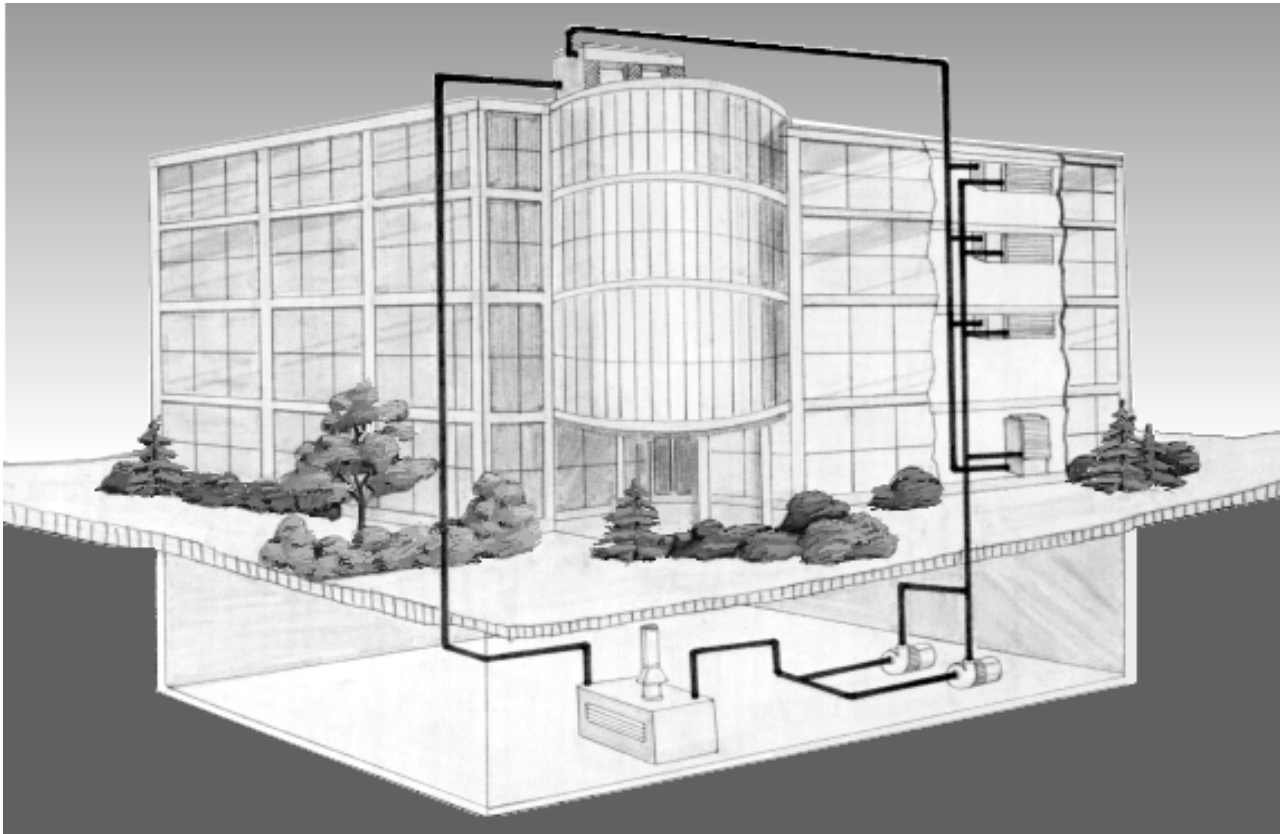


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Water-Source Boiler/Cooling Tower





GHP CONCEPTS

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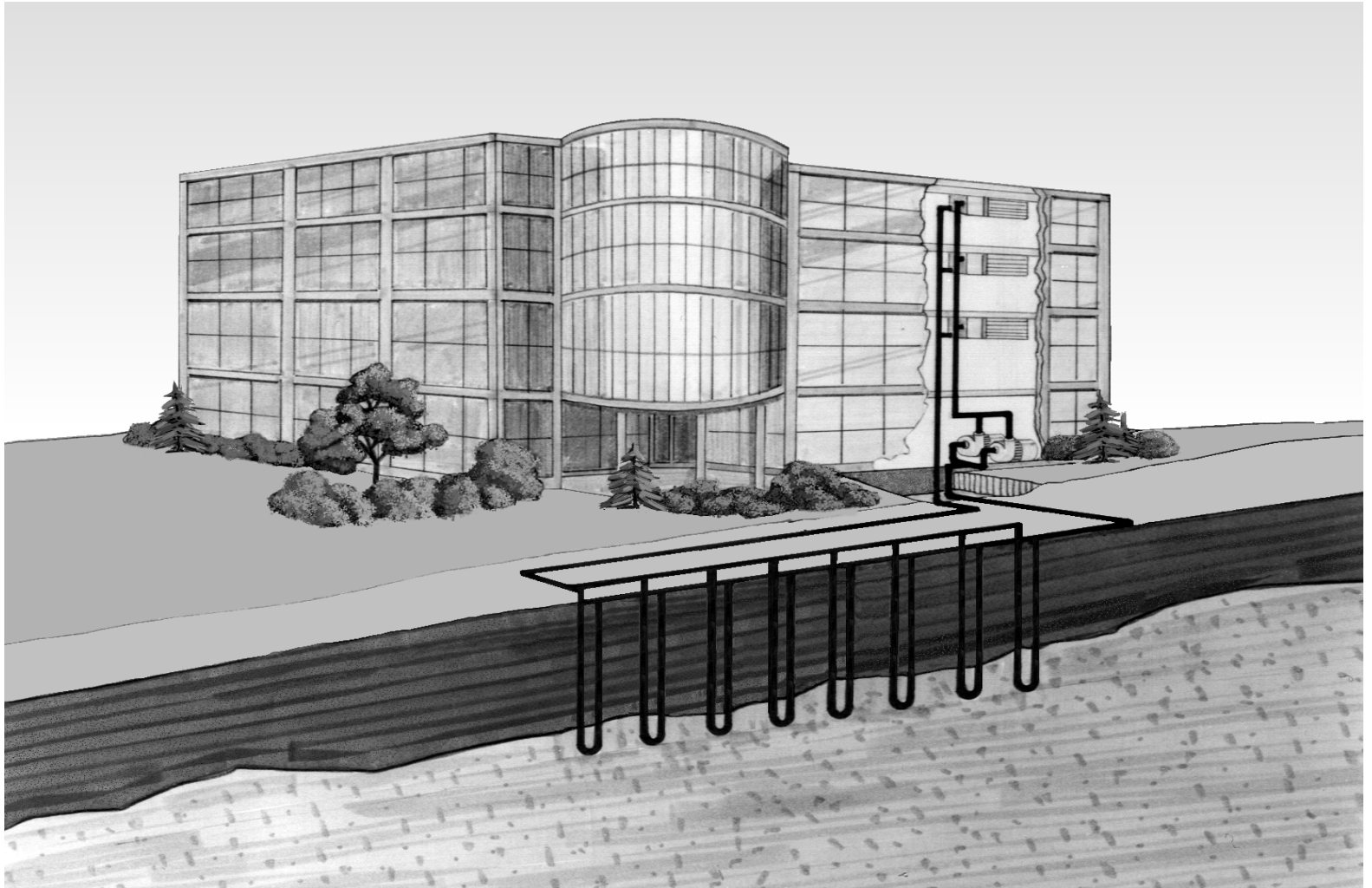


VERTICAL OPEN LOOP

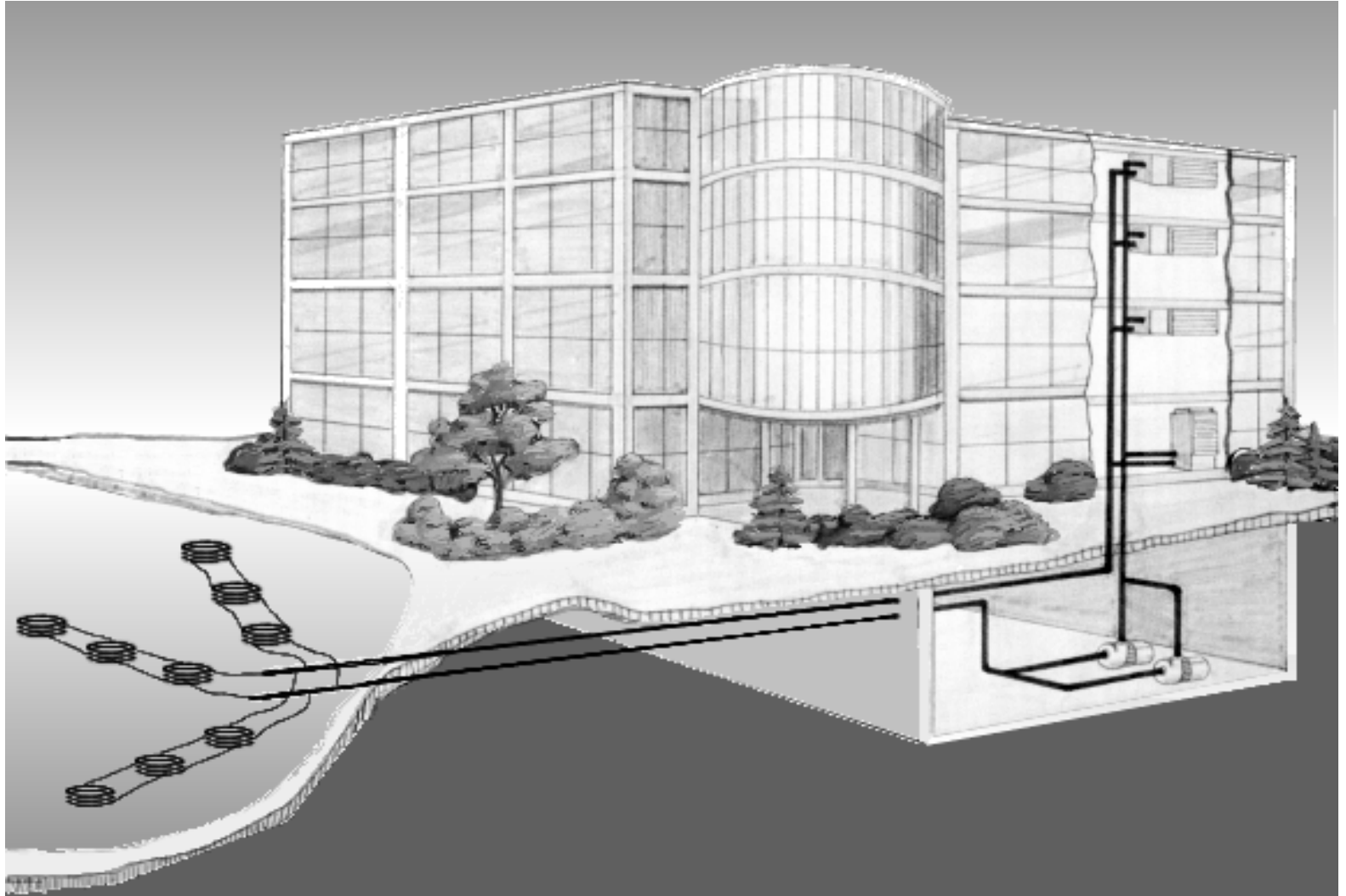




VERTICAL CLOSED LOOP



POND LOOP



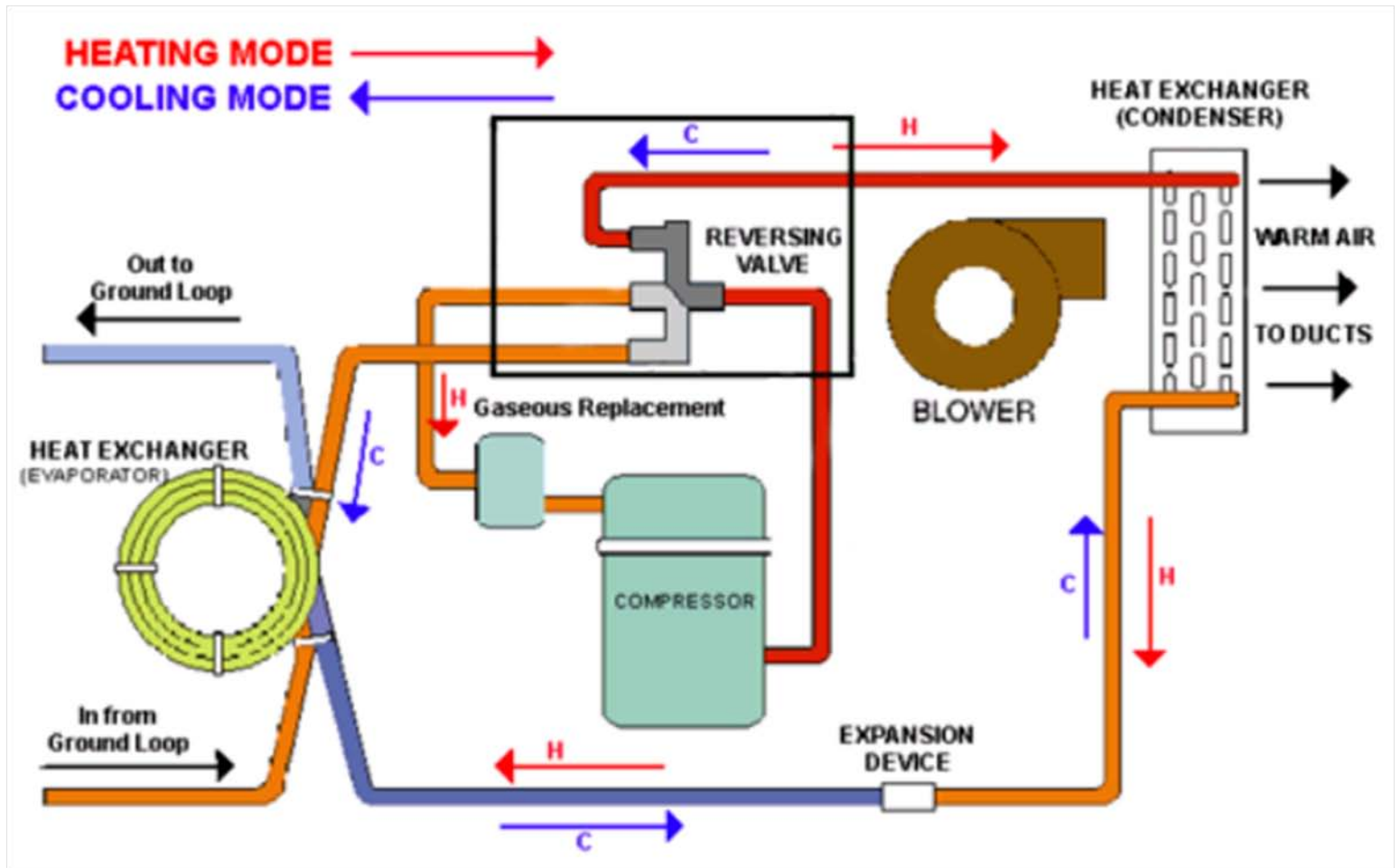


GHP CONCEPTS

- **GEO THERMAL HEAT PUMP**
 - WATER-TO-WATER
 - WATER-TO-AIR
 - HYBRID SYSTEMS

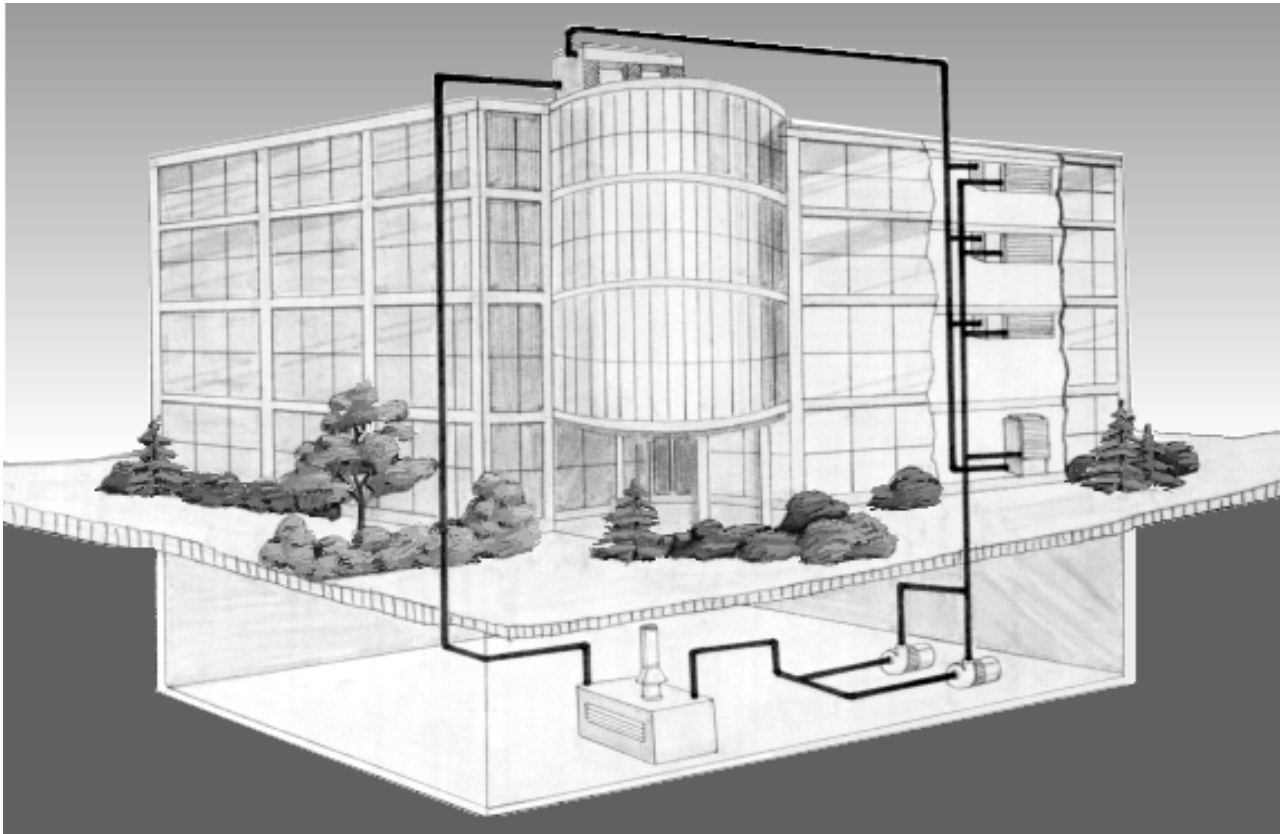


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Hybrid – Replace boiler with ground loop







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GHP CONCEPTS

GROUND HEAT EXCHANGER

(GROUND LOOP – EARTH HEAT XFER)

- BUILDING LOADS
- SOIL / ROCK CHARACTERISTICS
- MOISTURE CONTENT / WATER TABLE
- GROUT
 - HEAT TRANSFER CHARACTERISTICS
 - AQUIFER PROTECTION
- CIRCULATING FLUID



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GHP System Efficiency

- COOLING
 - Energy Efficiency Ratio (EER)
 - $\text{EER} = \frac{\text{Total Cooling Capacity in BTU/hour}}{\text{Power input in Watts}}$
- HEATING
 - Coefficient of Performance (COP)
 - $\text{COP} = \frac{\text{Heating Capacity in BTU/hour}}{\text{Power input in BTU/hour}}$
- $1 \text{ kWh} = 3413 \text{ BTU}$



GHP System Efficiency

**1 UNIT OF ENERGY
FROM THE GRID**

**YIELDS:
5 UNITS OF ENERGY
FOR A FACILITY**

**4 UNITS OF ENERGY
FROM THE EARTH**

500 % End-Use Efficiency (167% Source Energy Efficiency)



GHP REGULATION

- REFRIGERANTS (R-22, R410a, etc.)
- GROUND WATER REGULATION
 - AQUIFER PROTECTION
 - ANTI-FREEZE
- LICENSING
 - GROUND LOOP DESIGN & INSTALLATION
 - DRILLING



GHP LEGISLATION

- Bailout Bill GHP Tax Incentives
- Stimulus Bill GHP Tax Incentives and Grants
- Renewable Electricity Standard
- Energy Efficiency Resource Standard
- Climate Change Carbon Provisions
- State RES, EERS and Incentives



GHP INCENTIVES

- 10% FEDERAL INCOME TAX CREDIT
- GRANT IN LIEU OF TAX CREDIT
- ACCELERATED DEPRECIATION
- STATE INCENTIVES
- UTILITY INCENTIVES



GHP CASE STUDIES

- BALL STATE UNIVERSITY – MUNCIE, IN
CAMPUS-WIDE 45 BUILDINGS
4,100 BOREHOLES
<http://cms.bsu.edu/About/Geothermal.aspx>
- GALT HOUSE - LOUISVILLE, KY
4,500 TONS
1,200 HEAT PUMPS



GHP RESOURCES

- Environmental Protection Agency (Energy Star)
- U.S. Department of Agriculture
- U.S. Department of Defense
- U.S. Department of Energy
 - Federal Energy Management Program
 - National Renewable Energy Laboratory
 - Oak Ridge National Laboratory



GHP RESOURCES

Oak Ridge National Laboratory - December 2008

Geothermal (Ground-Source) Heat Pumps:

Market Status, Barriers to Adoption, and

Actions to Overcome Barriers

http://www.zebralliance.com/docs/geothermal_report_12-08.pdf



ORNL GHP CONCLUSIONS

GHPs use the only renewable energy resource that is available at every building's point of use, on-demand, that cannot be depleted (assuming proper design), and is potentially affordable in all 50 states



ORNL GHP CONCLUSIONS

GHPs have the potential to offset about 35 to 40 percent of the projected growth in building energy consumption between now and 2030.



GHP RESOURCES

- International Ground Source Heat Pump Association
<http://www.igshpa.okstate.edu/>
- National Ground Water Association
<http://www.ngwa.org/>
- American Ground Water Trust
<http://www.agwt.org/>
- Geothermal Resources Council
<http://www.geothermal.org/>
- Geothermal Heat Pump Consortium
<http://www.GeoExchange.org/>



THANK YOU

JOHN KELLY

Geothermal Heat Pump Consortium

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The York County School Division

Geothermal Schools:
Not Just Theory

York County Schools: The Search for Energy Efficiency

- **1997** Performance contract - replaced T-12 lighting in ten schools and installed DDC building automation systems in seven
- **2000** Installed the first geothermal system
- **2005** Energy Star Partner *10-point Reduction Award* for decreasing energy consumption
- **2006** Energy Star Leader and *20-point Reduction Award* for decreasing energy consumption
- **2007** Received first Energy Star Awards for four schools – all which were geothermal
- **2009** Received Energy Star Leader Top Performer Award
- **2009** Received Energy Star Awards for ten schools – six are geothermal
- **2010** Retrofitting geothermal into our eighth school - nearly half of our schools are geothermal

Proof Not Just Theory: Case Studies of Four Existing Geothermal Buildings

- 1. Seaford Elementary School***
- 2. Queen's Lake Middle School***
- 3. York Middle School***
- 4. Bruton High School***

Case Study # 1: Seaford Elementary School

Earned an Energy Star rating for three
consecutive years.

A photograph of Seaford Elementary School, a single-story brick building with large windows and a covered entrance. The school is surrounded by green grass and trees, with a paved road and sidewalk in the foreground. The sky is blue with white clouds.

Seaford Elementary School

A Certified Energy Star Building

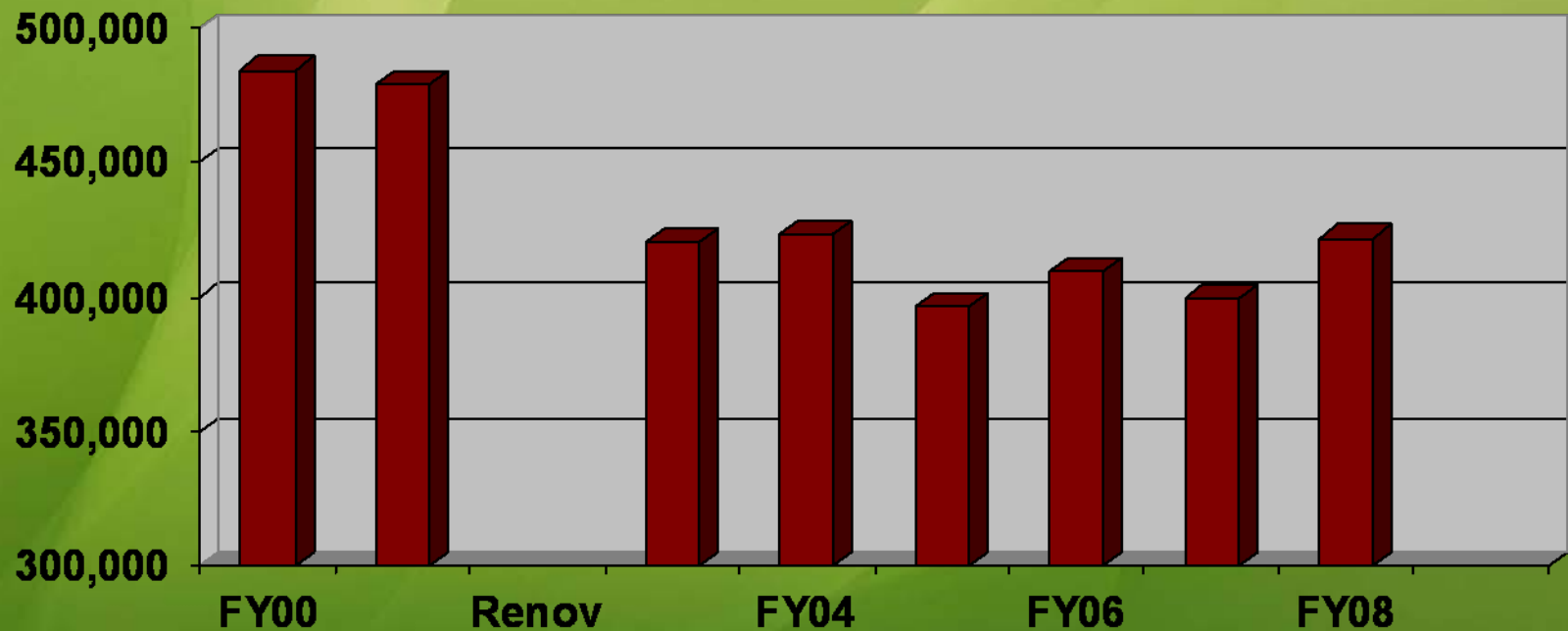
Energy Features *before* Geothermal Retrofit

- F32T8 Fluorescent lighting
- DDC Building Automation System
- Air to air heat pumps
- Fresh delivered through the heat pumps-
fresh air delivery was ineffective

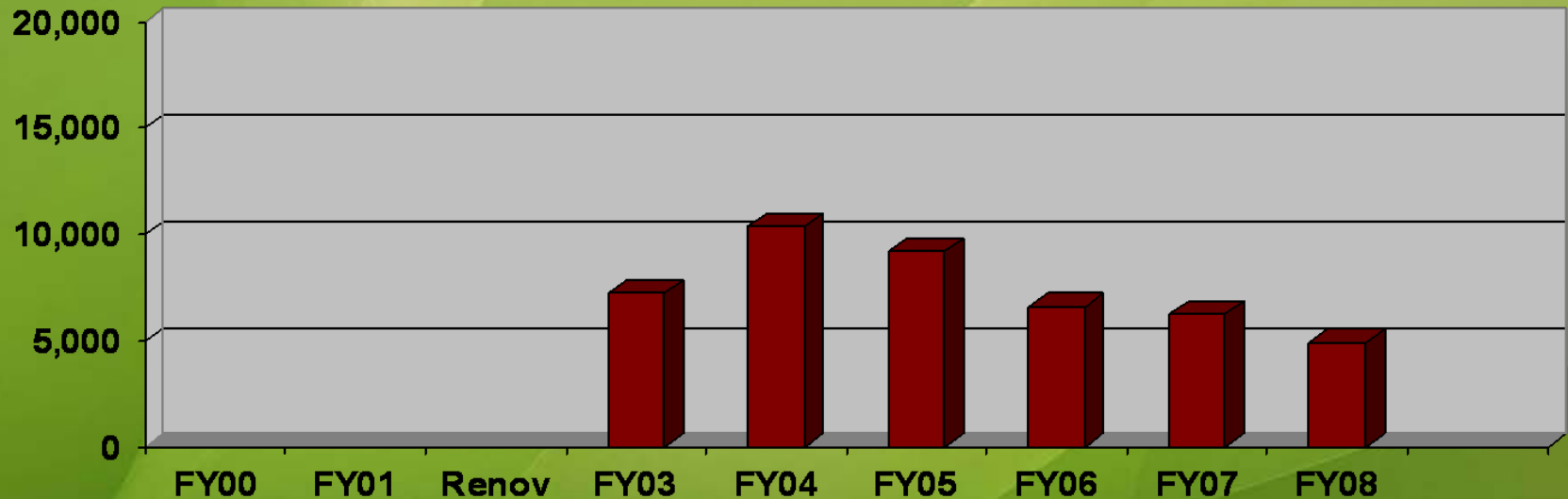
Energy Features *after* Retrofit

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent humidity monitoring
- Fresh air supplied to classrooms through dedicated makeup air systems
- Increased amount of fresh air delivered to classrooms
- Air-conditioned kitchen and hallways
- Added a 10,501 sqft air-conditioned gymnasium

Seaford Elementary – Electrical Consumption (kWh) by Fiscal Year



Seaford Elementary – Natural Gas Consumption (CCF) by Fiscal Year



Current Energy Intensity: 36.5 kBtu/sf/yr

Seaford Elementary School



Case Study # 2: Queens Lake Middle School

The first middle school in Virginia to earn an Energy Star rating. It has earned an Energy Star rating for three consecutive years.



Queens Lake Middle School

A Certified Energy Star Building

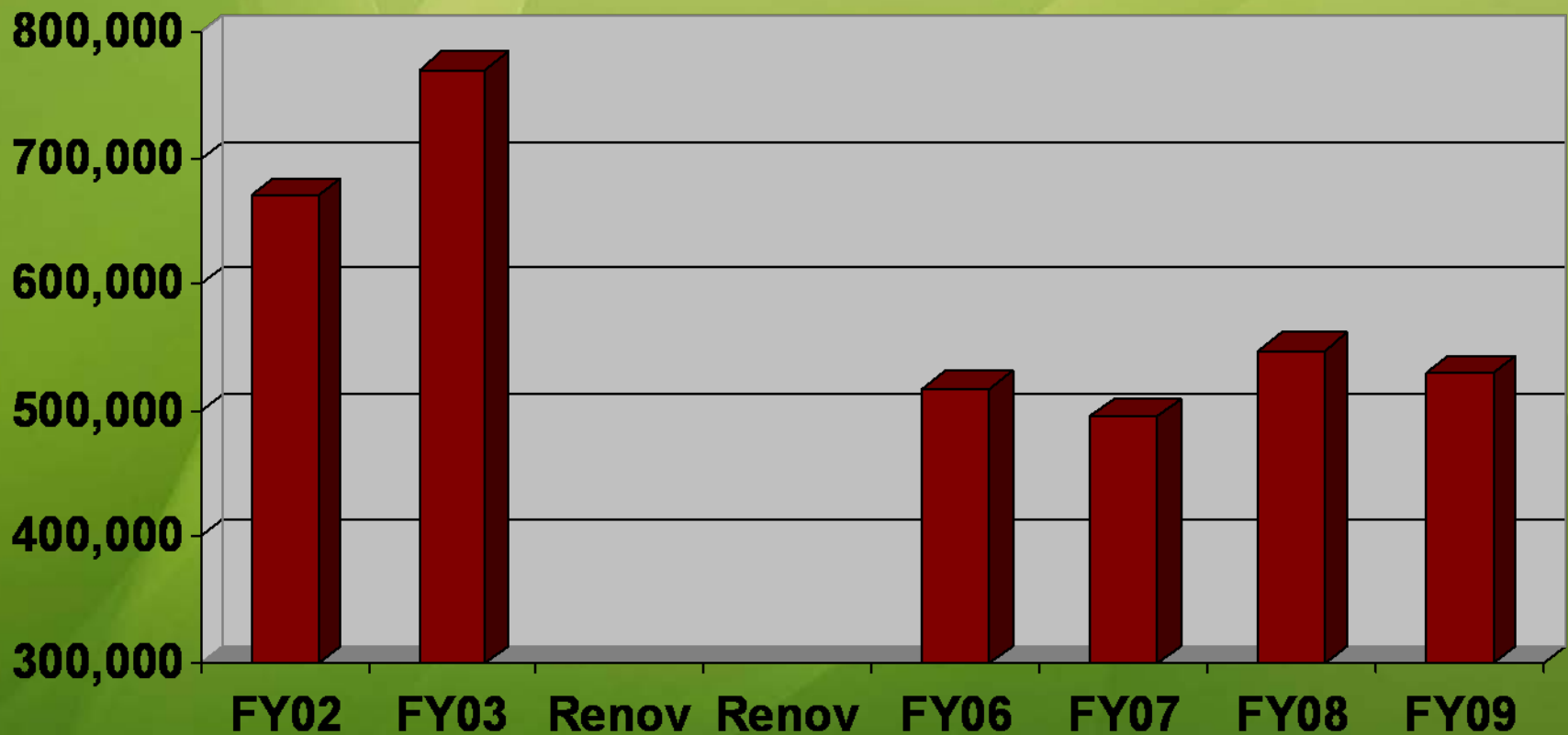
Energy Features *before* Renovation

- F32T8 Fluorescent lighting
- DDC Building Automation System
- Air to air heat pumps
- Fresh delivered through the heat pumps-found broken and seized dampers
- Gymnasium, locker rooms and kitchen were not air-conditioned

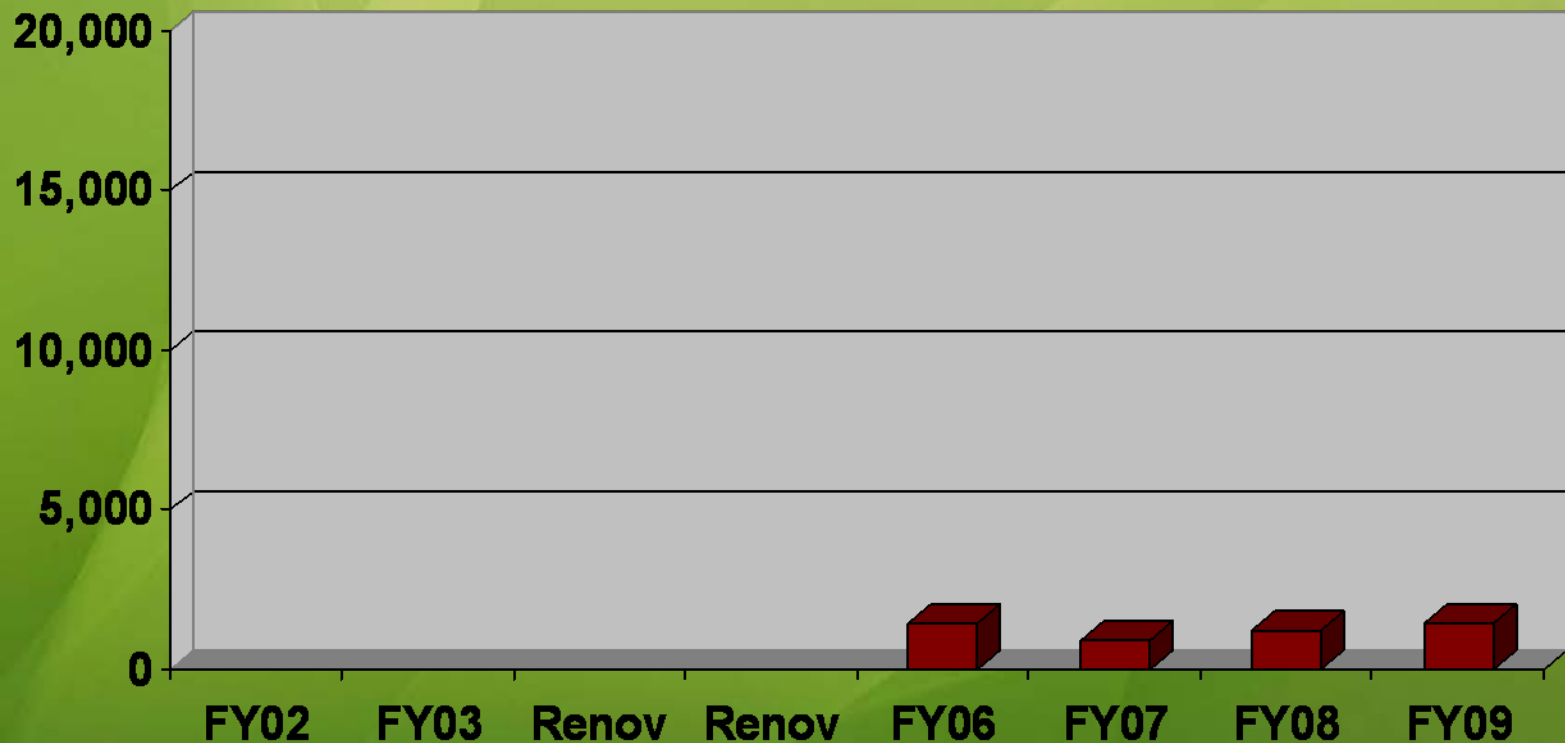
Energy Features *after* Renovation

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- VFD equipped circulating pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent CO2 and humidity monitoring
- Air-conditioned gym, locker rooms, kitchen and hallways
- Fresh air supplied through heat wheel style units
- Increased amount of fresh air delivered to classrooms
- Square footage increased from 47,767sqft to 56,075 sqft

Queens Lake Middle – Electrical Consumption (kWh) by Fiscal Year



Queens Lake Middle - Natural Gas Consumption (CCF) by Fiscal Year



Current Energy Intensity: 32.9 kBtu/sf/yr



Queens Lake Middle School



Case Study # 3: York Middle School

An Energy Star Certified Building



York Middle School

An Energy Star Certified Building

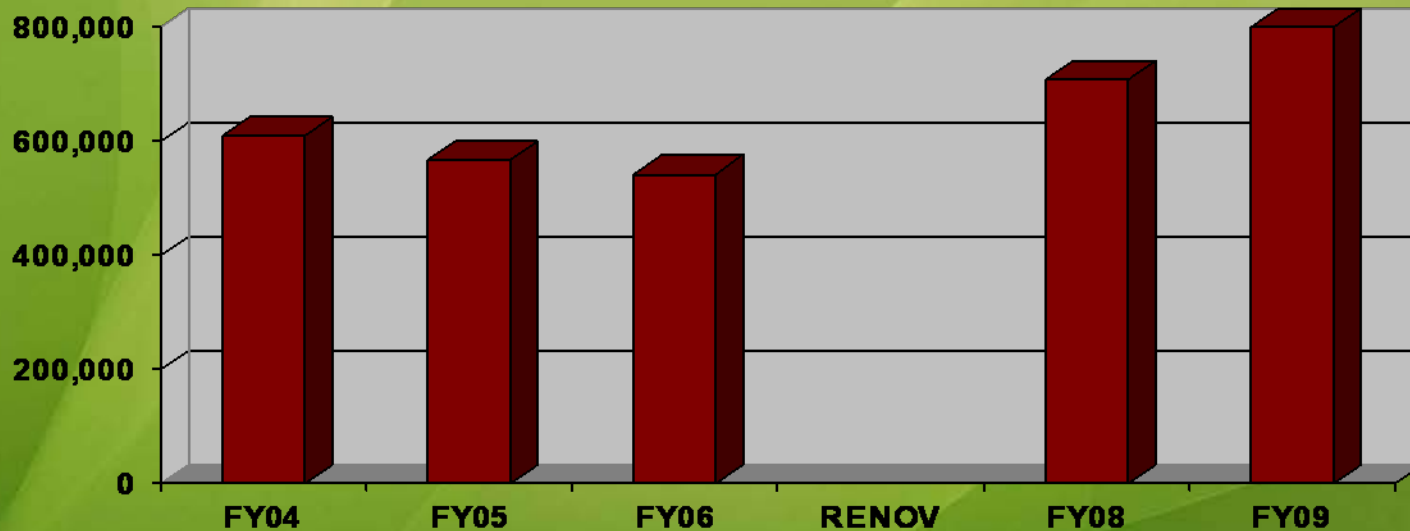
Energy Features *before* Renovation

- F34T12 fluorescent lighting
- Pneumatically controlled unit ventilators
- Fresh air was delivered through the unit ventilators - fresh air delivery effectiveness was questionable
- Pilot DDC Building Automation System
- Natural gas fired boilers
- Gym, locker rooms and kitchen were not air-conditioned

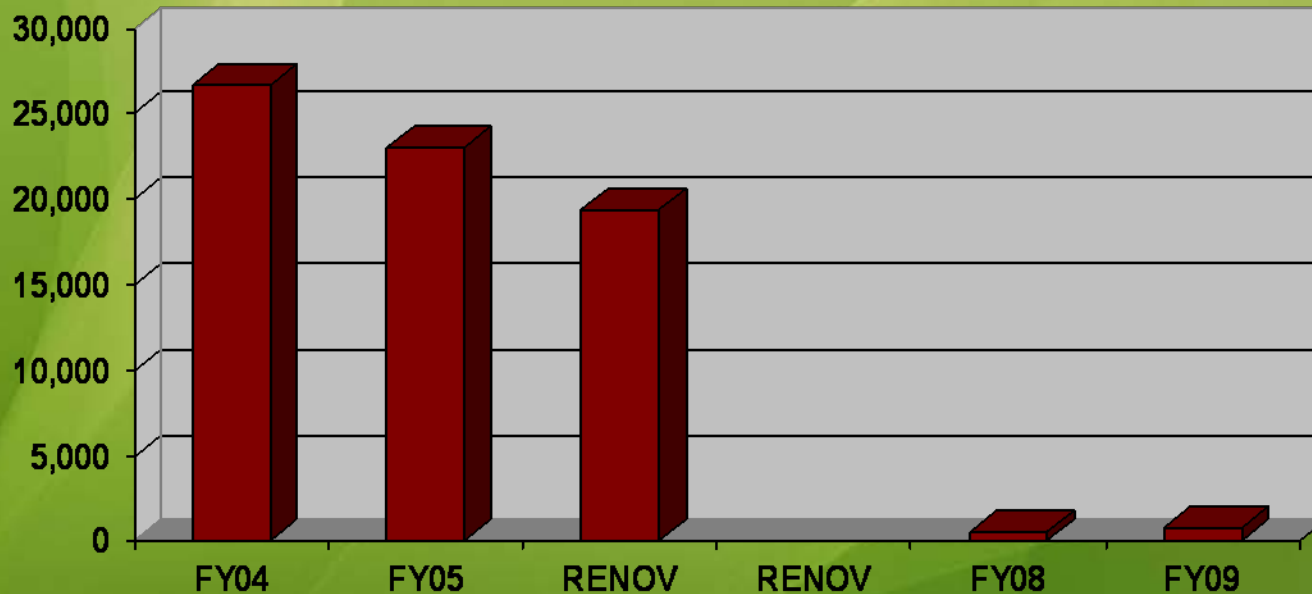
Energy Features *after* Renovation

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- VFD equipped circulating pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent CO2 and humidity monitoring
- Air-conditioned auditorium, gymnasium, locker rooms, kitchen and hallways
- Fresh air supplied through heat wheel style units
- Increased amount of fresh air delivered to classrooms
- Added 24,500 sqft classroom space and media center

York Middle School – Electrical Consumption (kWh) by Fiscal Year



York Middle - Natural Gas Consumption (CCF) by Fiscal Year



Current Energy Intensity: 27.1 Btu/sf/yr



York Middle School



Case Study # 4: Bruton High School

The first high school in Virginia to earn an Energy Star rating. It has earned the Energy Star rating for three consecutive years.

A photograph of Bruton High School. The building is a large, modern structure with a curved roof and brick walls. It is surrounded by green grass, trees, and shrubs. A paved road with yellow markings is in the foreground. A flagpole is visible on the right side of the building.

Bruton High School

A Certified Energy Star Building

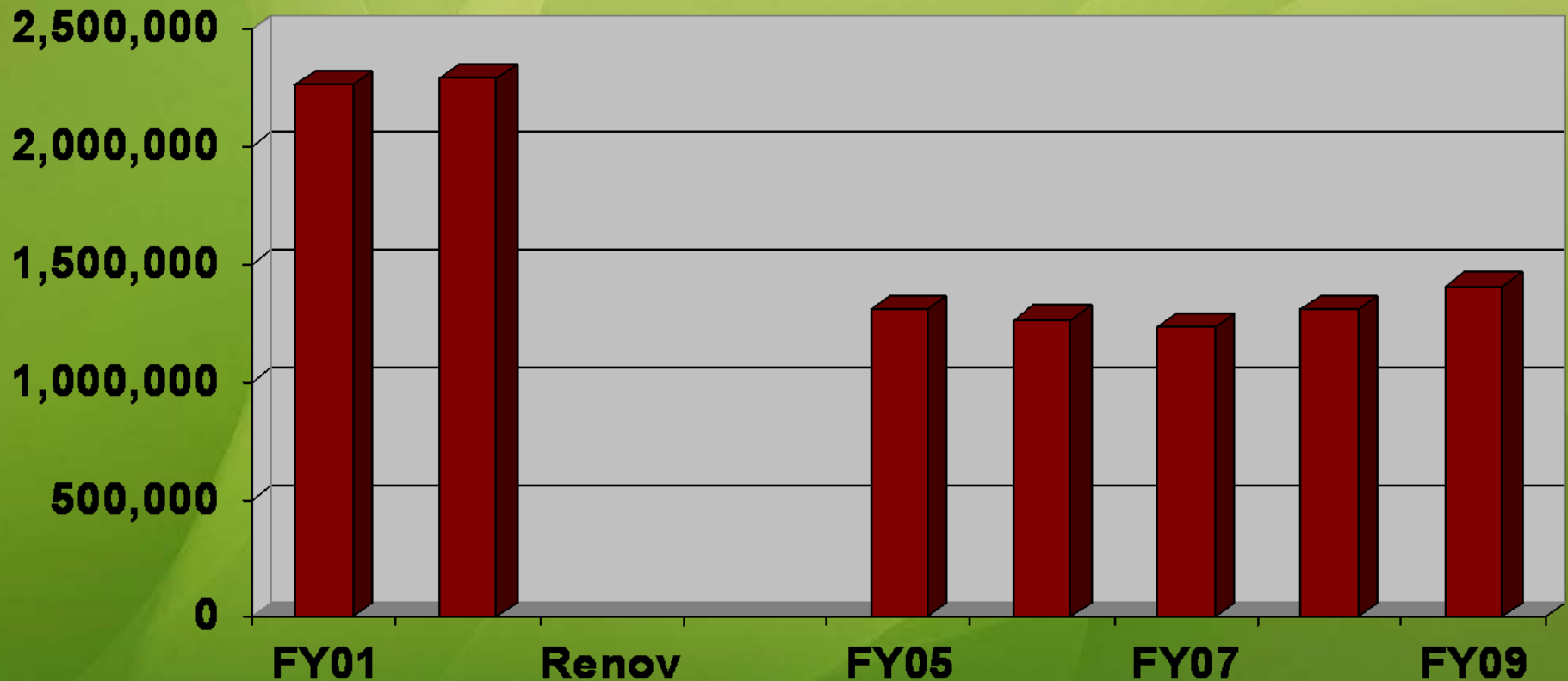
Energy Features *before* Renovation

- F34T12 fluorescent lighting
- Pilot DDC Building Automation System
- Packaged all electric rooftop multi-zone units
- Fresh air delivered through the multi-zone units-
fresh air delivery was ineffective
- Gym, locker rooms and kitchen were not air-
conditioned

Energy Features *after* Renovation

- F32T8 Fluorescent lighting
- Occupancy sensors
- Geothermal heat pumps
- VFD equipped circulating pumps
- DDC Building Automation System
- Adjustable room temperature setpoints & overrides
- Permanent CO2 and humidity monitoring
- Air-conditioned gym, locker rooms and kitchen
- Fresh air supplied through heat wheel style units
- Increased amount of fresh air delivered to classrooms
- Added a 2,870 sqft air-conditioned practice gymnasium

Bruton High School – Electrical Consumption (kWh) by Fiscal Year

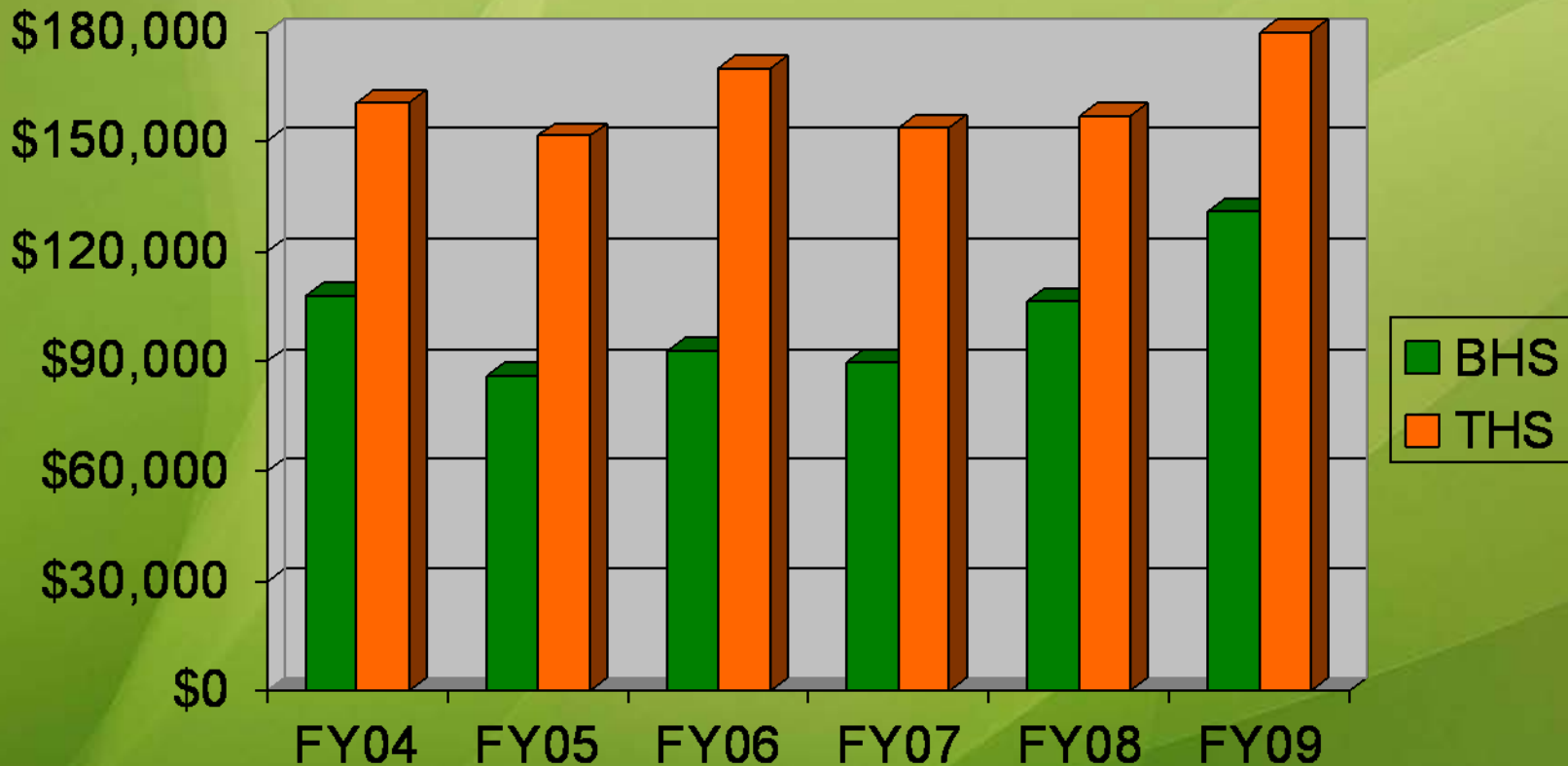


Current Energy Intensity: 29.2 kBtu/sf/yr

Bruton High School



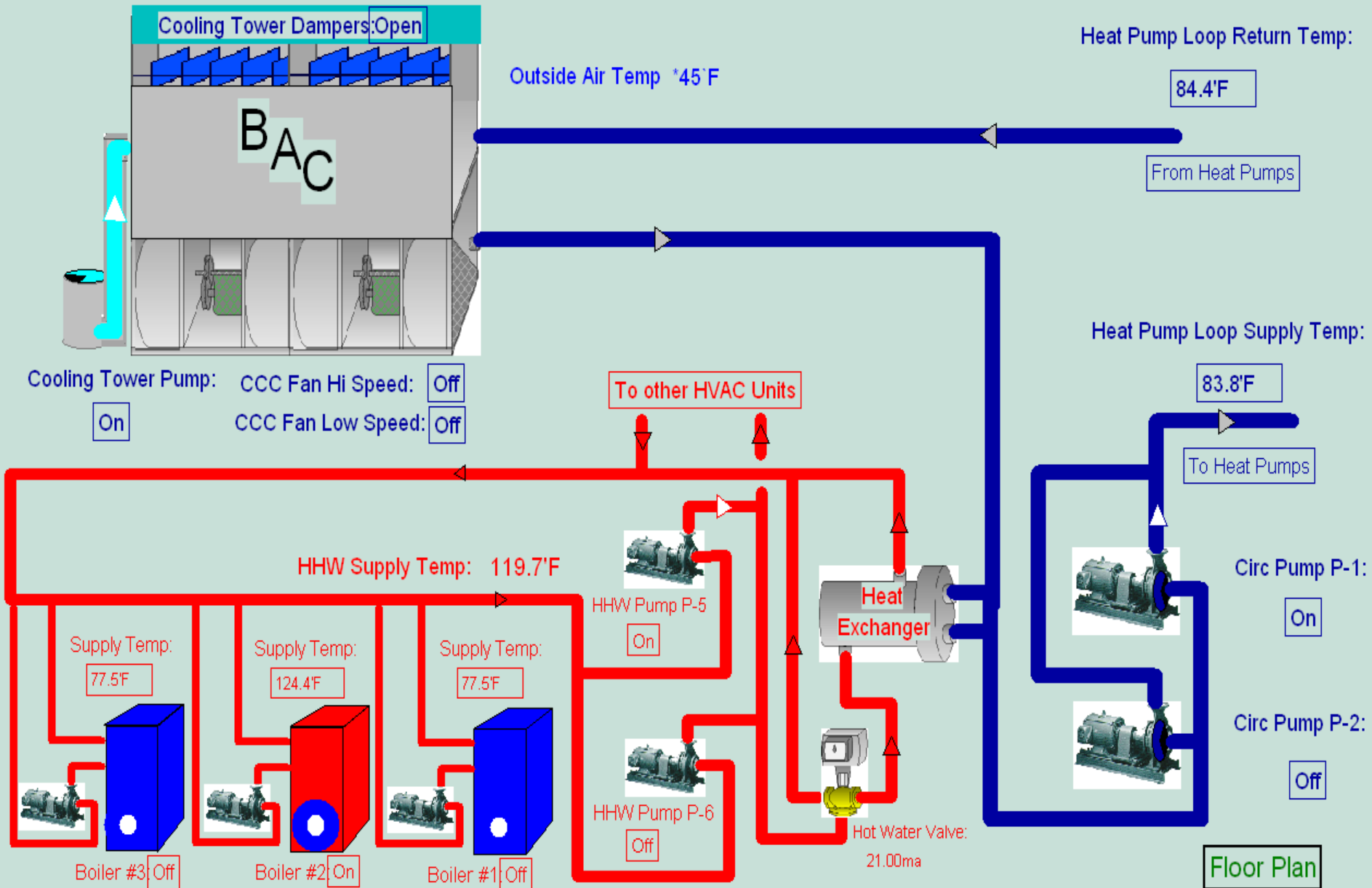
Comparison of a Geothermal Installation versus a Traditional HVAC System



Bruton High School – (152,656 sq ft) total yearly cost includes electricity and propane gas

Tabb High School – (157,307 sq ft) total yearly cost includes electricity and natural gas

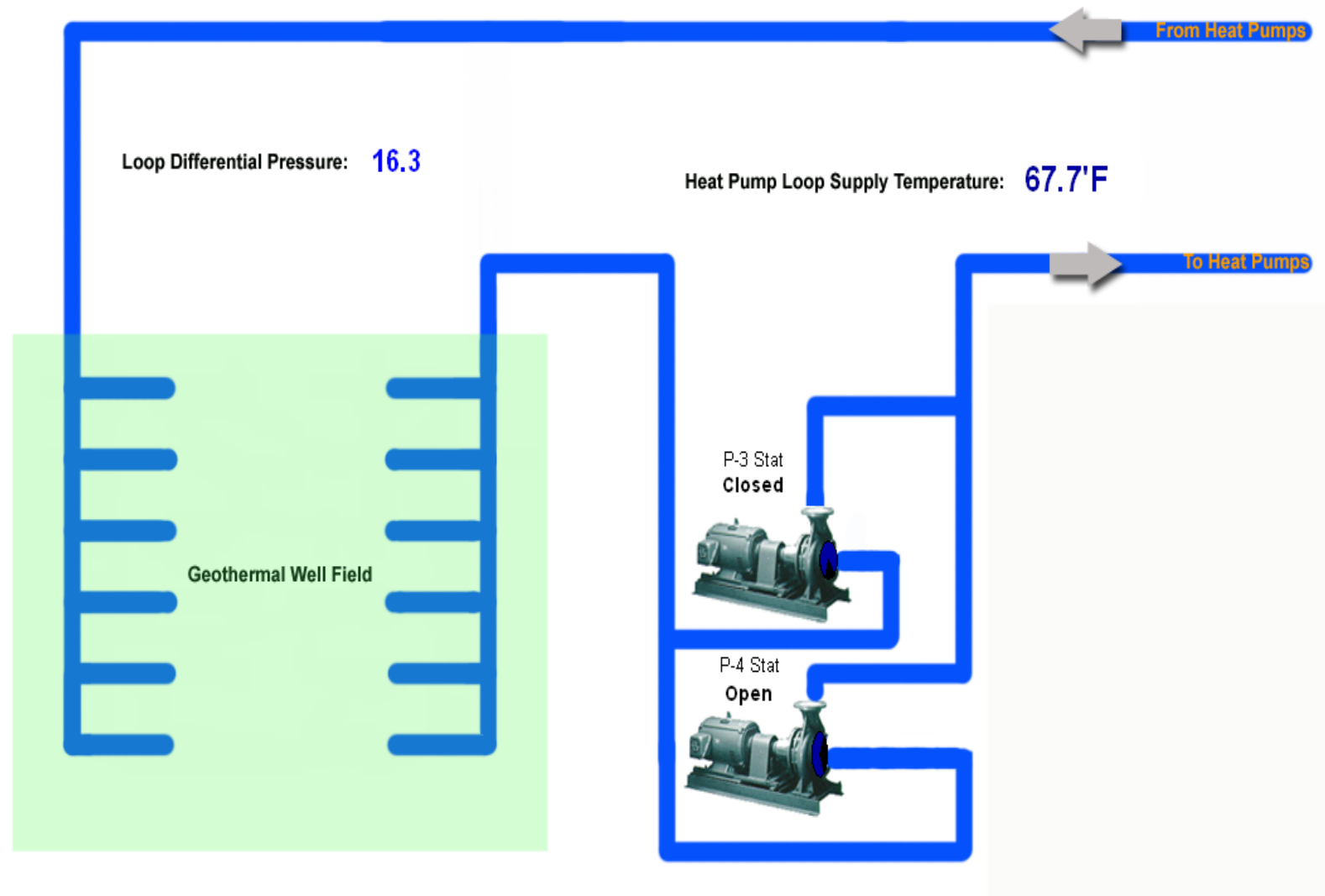
Tabb High Boiler Room



Bruton High School - Geothermal System 1 - Instructional Wing

Outside Air: 65°F

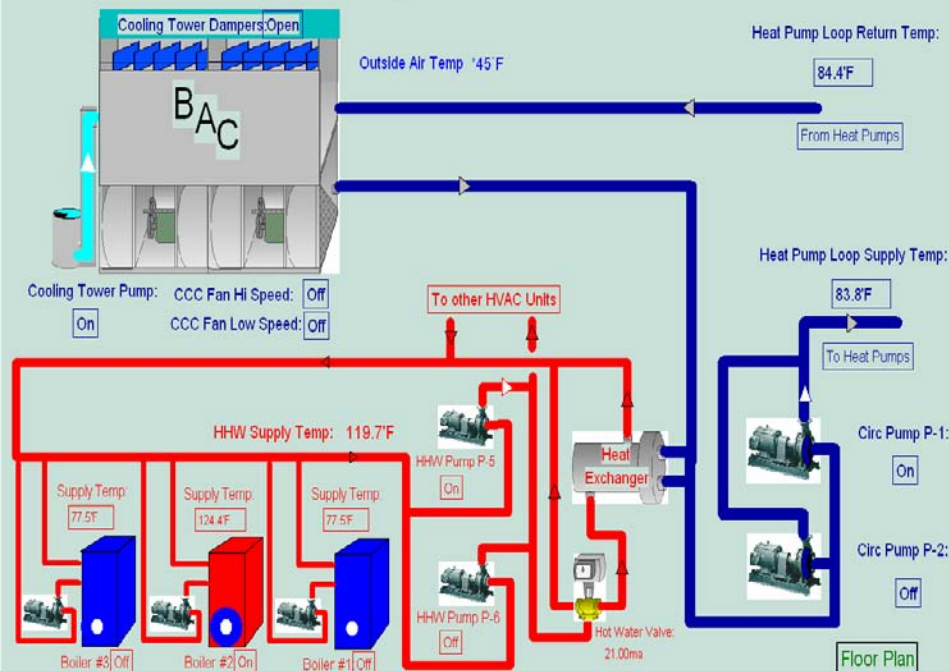
Heat Pump Loop Return Temperature: 72.7°F



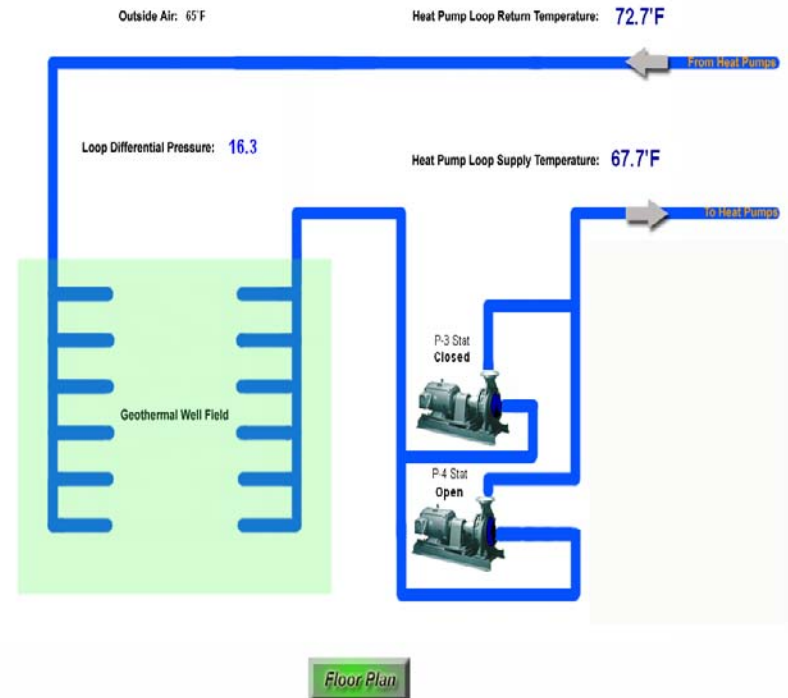
Floor Plan

A Side by Side Comparison...

Tabb High Boiler Room



Bruton High School - Geothermal System 1 - Instructional Wing



Which would you rather maintain?



Mark Tschirhart

Supervisor of Resource and Security Control

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www.yorkcountyschools.org/greenYCSD

green.yorkcountyschools.org

Questions & Discussion

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- *** 6** to mute phone.

Upcoming Web Conferences



April – Constant Commissioning

May – Award Winning Energy Programs

June – Driving Responsibility for Energy Use

July – How to Launch an Energy
Competition

Register online at:

energystar.webex.com/meetings

- Thank you